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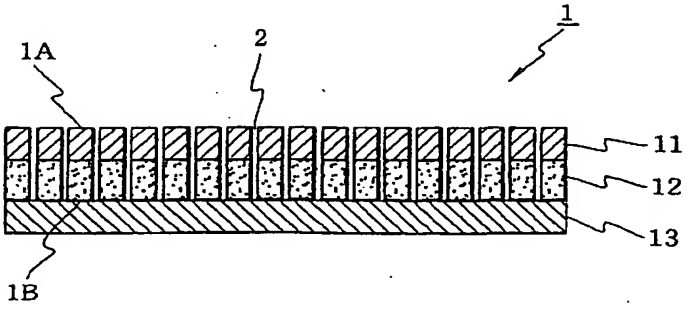
(54) ADHESIVE SHEET

(57) To provide a pressure-sensitive adhesive sheet according to which air entrapment and blistering can be prevented or eliminated via through-holes, and yet the appearance compares favorably with that of a pressure-sensitive adhesive sheet having no through-holes therein, as a substrate 11 there is used one having a surface roughness (Ra) of not less than 0.03 μm, a lightness (L*) in the L*a*b* color system of not more than 60 in the case of having a chroma (C*) of not more than 60 and a lightness (L*) of not more than 85 in the case of having a chroma (C*) greater than 60, and a contrast ratio of not less than 90%, through-holes 2 passing through the substrate 11 and a pressure-sensitive adhesive layer 12 are made to have a diameter in the substrate 11 and the pressure-sensitive adhesive layer 12 of from 0.1 to 200 μm, a diameter at a surface of the substrate 11 of from 0.1 to 42 μm, and a hole density of from 30 to 50, 000 per 100 cm^2, in the case that melted portions formed by a laser are present around the through-holes 2 at the surface of the substrate 11, the melted portions are made to have an outside diameter of not more than 50 μm, and in the case that thermally deformed portions are present around the through-holes 2 at the surface of the substrate 11, the thermally deformed portions are made to have an outside diameter of not more than 180 μm.

Fig.1



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(portions around the peripheries of the through-holes) to swell or the like so that the appearance of the pressure-sensitive adhesive sheet is marred.

[0010] The present invention has been devised in view of the above state of affairs; it is an object of the present invention to provide a pressure-sensitive adhesive sheet according to which air entrapment and blistering can be prevented or eliminated via through-holes, and yet the appearance compares favorably with that of a pressure-sensitive adhesive sheet having no through-holes therein.

MEANS FOR SOLVING THE PROBLEM

[0011] To attain the above object, the present invention provides a pressure-sensitive adhesive sheet comprising a substrate having a surface roughness (Ra) of not less than 0.03 μm, a lightness (L*) in the L*a*b* color system of not more than 60 in the case of having a chroma (C*) of not more than 60 and a lightness (L*) of not more than 85 in the case of having a chroma (C*) greater than 60, and a contrast ratio of not less than 90%, and a pressure-sensitive adhesive layer, the pressure-sensitive adhesive sheet wherein the pressure-sensitive adhesive sheet is formed with a plurality of through-holes passing through from one surface to the other surface thereof at a hole density of from 30 to 50,000 per 100cm^2 through laser processing, the through-holes have a diameter in the substrate and the pressure-sensitive adhesive layer of from 0.1 to 200 μm, the through-holes have a diameter at a surface of the substrate of from 0.1 to 42 μm, melted portions formed by the laser around the through-holes at the surface of the substrate have an outside diameter of not more than 50 μm, and thermally deformed portions formed by the laser around the through-holes or around the melted portions at the surface of the substrate have an outside diameter of not more than 180 μm (invention 1).

[0012] Note that in the present specification, "sheet" is deemed to include the idea of a film, and "film" is deemed to include the idea of a sheet. Here, "melted portion formed by the laser" means a portion where melted matter so-called "dross" formed by the laser is present, and "thermally deformed portion formed by the laser" means a convex or concave deformed portion formed around the opening of a through-hole or around a melted portion by the laser. Moreover, "melted portions ... have an outside diameter of not more than 50 μm" is deemed to include the case that such melted portions do not exist, and "thermally deformed portions ... have an outside diameter of not more than 180 μm" is deemed to include the case that such thermally deformed portions do not exist.

[0013] According to the pressure-sensitive adhesive sheet of the above inventions (inventions 1), air between an adherend and the pressure-sensitive adhesive surface escapes from the through-holes to the outside of the pressure-sensitive adhesive sheet front surface, and hence air tends not to be caught up when sticking the pressure-sensitive adhesive sheet to the adherend, i. e. air entrapment can be prevented from occurring. Even if air is caught up so that air entrapment occurs, by re-pressing the air-entrapped portion or an air-entrapped portion surrounding portion ncluding the air-entrapped portion, the air can be made to escape from the through-holes to the outside of the pressure-sensitive adhesive sheet front surface, thus eliminating the air entrapment. Moreover, even if gas is emitted from the adherend after the pressure-sensitive adhesive sheet has been stuck onto the adherend, the gas will escape from the through-holes to the outside of the pressure-sensitive adhesive sheet front surface, whereby blistering can be prevented from occurring.

[0014] Moreover, according to the pressure-sensitive adhesive sheet satisfying the above conditions, none of the through-holes, melted portions or thermally deformed portions can be seen with the naked eye on the substrate surface, therefore the appearance is no different to that of a pressure-sensitive adhesive sheet having no through-holes therein.

[0015] In the case of the above invention (invention 1), in the case that the pressure-sensitive adhesive sheet is stuck onto an adherend stretched by a elongation of up to 3%, preferably, the substrate has a surface roughness (Ra) of not less than 0.1 μm, and the through-holes have a diameter in the substrate and the pressure-sensitive adhesive layer of from 0.1 to 85 μm (invention 2).

[0016] According to the pressure-sensitive adhesive sheet of the above invention (invention 2), even in the case that the pressure-sensitive adhesive sheet is stuck on stretched by a elongation of up to 3%, none of the through-holes, melted portions or thermally deformed portions can be seen with the naked eye on the substrate surface, therefore the appearance is no different to that of a pressure-sensitive adhesive sheet having no through-holes therein.

[0017] In the case of the above inventions (inventions 1 and 2), preferably, the diameter of the through-holes at the surface of the substrate is less than the diameter of the through-holes at a pressure-sensitive adhesive surface of the pressure-sensitive adhesive layer (invention 3).

ADVANTAGEOUS EFFECT OF THE INVENTION

[0018] According to the pressure-sensitive adhesive sheet of the present invention, air entrapment and blistering can be prevented or eliminated via through-holes, and yet the through-holes, and melted portions and thermally deformed portions which may be formed along with the through-holes, cannot be seen with the naked eye on the substrate surface,

speed of 200 mm/min.

[0028] There are no particular limitations on the material of the substrate 11 so long as this is a material that satisfies the above conditions and in which the through-holes 2 can be formed; examples include a resin film, a metal foil, paper, a resin film having metal deposited thereon by vapor deposition, paper having metal deposited thereon by vapor deposition, fabric, nonwoven fabric, or a laminate of the above. These materials may contain any of various additives such as inorganic fillers, organic fillers, and ultraviolet absorbers.

[0029] The surface of the material may have a decorative layer formed thereon by a method such as printing, painting, transfer printing, vapor deposition, or sputtering, or may have formed thereon an undercoat layer such as an adhesion facilitating coat for forming such a decorative layer, or a gloss adjusting coat, or may have formed thereon a topcoat layer such as a hardcoat, an antifouling coat, or a surface roughness or specular gloss adjusting coat. Moreover, such a decorative layer, undercoat layer or topcoat layer may be formed over the whole of the material, or may be formed on only part of the material.

[0030] As a resin film, there can be used, for example, a film or a foamed film made of a resin such as a polyolefin such as polyethylene or polypropylene, a polyester such as polyethylene terephthalate or polybutylene terephthalate, polyvinyl chloride, polystyrene, a polyurethane, a polycarbonate, a polyamide, a polyimide, polymethyl methacrylate, polybutene, polybutadiene, polymethylpentene, anethylene-vinylacetate copolymer, anethylene-(meth)acrylic acid copolymer, an ethylene-(meth)acrylate ester copolymer, an ABS resin, or an ionomer resin, or a thermoplastic elastomer containing a component such as a polyolefin, a polyurethane, polystyrene, polyvinyl chloride or a polyester, or a laminated film of the above. As the resin film, a commercially available one may used, or one formed by a casting method or the like using a casting sheet may be used. Moreover, as paper, for example,woodfreepaper,glassinepaper,coatedpaper, laminated paper, dust-free paper, or Japanese paper can be used.

[0031] There are no particular limitations on the above casting sheet, for example, any of various types of paper, or a resin film such as polyethylene terephthalate, polypropylene, polyethylene or the like that has been subjected to release treatment with a release agent of a silicone type, a polyester type, an acrylic type, an alkyd type, a urethane type or the like or a synthetic resin can be used. The thickness of the casting sheet is generally approximately 10 to 200 μm, preferably approximately 25 to 150 μm.

[0032] The thickness of the substrate 11 is generally approximately from 1 to 500 μm, preferably from 3 to 300 μm, but may be changed as appropriate in accordance with the use of the pressure-sensitive adhesive sheet 1.

[0033] There are no particular limitations on the type of the pressure-sensitive adhesive constituting the pressure-sensitive adhesive layer 12 so long as the through-holes 2 can be formed therein; the pressure-sensitive adhesive may be any of an acrylic type, a polyester type, a polyurethane type, a rubber type, a silicone type, or the like. Moreover, the pressure-sensitive adhesive may be any of an emulsion type, a solvent type, or a solvent-less type, and may be either a crosslinked type or a non-crosslinked type.

[0034] The thickness of the pressure-sensitive adhesive layer 12 is generally approximately from 1 to 300 μm, preferably from 5 to 100 μm, but may be changed as appropriate in accordance with the use of the pressure-sensitive adhesive sheet 1.

[0035] There are no particular limitations on the material of the release liner 13; for example, a film or foamed film made of a resin such as polyethylene terephthalate, polypropylene or polyethylene, or paper such as glassine, coated paper or laminated paper that has been subjected to release treatment with a release agent such as a silicone type one, a fluorine type one or a long chain alkyl group-containing carbamate can be used.

[0036] The thickness of the release liner 13 is generally approximately from 10 to 250 μm, preferably approximately from 20 to 200 μm. Moreover, the thickness of the release agent in the release liner 13 is generally from 0 . 05 to 5 μm, preferably from 0.1 to 3 μm.

[0037] The through-holes 2 passing through the substrate 11 and the pressure-sensitive adhesive layer 12 are formed through laser processing, described below. Through the laser processing, minute through-holes with good air escaping ability can easily be formed at a desired hole density.

[0038] In the present embodiment, the through-holes 2 have a diameter in the substrate 11 andthepressure-sensitiveadhesive layer 12 of from 0.1 to 200 μm, preferably from 0.1 to 150 μm, and a diameter at the surface of the substrate 11 of from 0.1 to 42 μm, preferably from 0.1 to 40 μm.

[0039] Moreover, depending on the material of the substrate 11 and the type of the laser, melted matter (dross) may be formed around the openings of the through-holes 2 through the laser processing as shown in FIG. 2; in this case, each portion (melted portion) 3 where the melted matter is present has an outside diameter D1 at the surface of the substrate 11 of not more than 50 μm, preferably not more than 45 μm. The melted matter generally has a height of not more than 10 μm, preferably not more than 7 μm.

[0040] Furthermore, depending on the material of the substrate 11 and the type of the laser, convex or concave thermally deformed portions 4 may be formed around the openings of the through-holes 2 or around the melted portions 3 through the laser processing as shown in FIGS. 3 (a) and (b) ; in the case that such thermally deformed portions 4 are present, each thermally deformed portion 4 has an outside diameter D2 at the surface of the substrate 11 of not

sensitive adhesive layer 12.

[0052] In the present producing method, the formation of the through-holes 2 is carried out by laser processing, the pressure-sensitive adhesive layer 12 being irradiated directly with a laser from the pressure-sensitive adhesive layer 12 side. By carrying out the laser processing from the pressure-sensitive adhesive layer 12 side in this way, even if the through-holes 2 become tapered, the diameter of the through-holes 2 can be made to be smaller on the substrate 11 side than on the pressure-sensitive adhesive layer 12 side, and hence it is easy to control the diameter of the through-holes 2 at the surface of the substrate 11 to be within the range described earlier (0.1 to 40 μm).

[0053] Moreover, by temporarily peeling off the release liner 13 and irradiating the pressure-sensitive adhesive layer 12 with the laser directly, there is no widening of the openings of each of the through-holes 2 in the pressure-sensitive adhesive layer 12 due to thermally melted matter from the release liner 13, and hence the degree of precision of the diameter and the hole density will be high, and thus through-holes 2 can be formed that will not be prone to being entered by water or the like which might have an adverse effect on the pressure-sensitive adhesive sheet 1. Furthermore, when irradiating the pressure-sensitive adhesive layer 12 with the laser, by making the release liner 13 do not present there between, the laser irradiation time can be shortened, or the laser output energy can be reduced. If the laser output energy is reduced, then thermal effects on the pressure-sensitive adhesive layer 12 and the substrate 11 will be reduced, and hence it will be possible to form through-holes 2 of uniform shape with little melted matter or thermal deformation.

[0054] There are no particular limitations on the type of the laser used in the laser processing; for example, a carbon dioxide (CO_2) laser, a TEA-CO_2 laser, a YAG laser, a UV-YAG laser, an excimer laser, a semiconductor laser, a YVO_4 laser, a YLF laser, or the like can be used.

[0055] In the present producing method, as the substrate 11, one formed by a casting method or the like using a casting sheet may be used; in this case, the casting sheet is laminated on the surface of the substrate 11. Moreover, in the present producing method, before carrying out the laser processing, a peelable protective sheet may be laminated onto the surface of the substrate (on which a casting sheet has not been laminated) 11 at a desired stage. As the protective sheet, for example a publicly known pressure-sensitive adhesive protective sheet comprising a substrate and a removable pressure-sensitive adhesive layer can be used.

[0056] When the through-holes 2 are formed through the laser processing, melted matter may be come attached around the openings of the through-holes 2, but through the casting sheet or protective sheet being present on the surface of the substrate 11, the melted matter will become attached to the casting sheet or protective sheet rather than the substrate 11, and hence the appearance of the pressure-sensitive adhesive sheet 1 can be better maintained.

[0057] In the above case, when irradiating with the laser from the pressure-sensitive adhesive layer 12 side, the through-holes 2 must be formed in at least the pressure-sensitive adhesive layer 12 and the substrate 11; the through-holes 2 may formed as far as part way through the casting sheet or protective sheet, or may pass completely through the casting sheet or protective sheet.

[0058] Note that in the above producing method, the pressure-sensitive adhesive layer 12 was formed on the release liner 13, and then the substrate 11 was stuck onto the formed pressure-sensitive adhesive layer 12, but there is no limitation to this in the present invention, for example the pressure-sensitive adhesive layer 12 may be coated on the substrate 11 directly. Moreover, the laser processing may be carried out in a state with the release liner 13 laminated on, and furthermore the irradiation with the lasermay be carried out from the side of the substrate 11 or a casting sheet or protective sheet as described above.

[Use of pressure-sensitive adhesive sheet]

[0059] When sticking the pressure-sensitive adhesive sheet 1 onto an adherend, firstly the release liner 13 is peeled off from the pressure-sensitive adhesive layer 12. In the case that there is a casting sheet or protective sheet through which the through-holes 2 do not pass on the substrate 11, the casting sheet or protective sheet is peeled off. In the case that the through-holes 2 pass through such a casting sheet or protective sheet, the casting sheet or protective sheet may be peeled off at this stage, or may be peeled off after the pressure-sensitive adhesive sheet 1 has been stuck on.

[0060] Next, the pressure-sensitive adhesive surface 1B of the pressure-sensitive adhesive layer 12 that has been exposed through the release liner 13 being peeled off is made to be in close contact with the adherend, and then the pressure-sensitive adhesive sheet 1 is pressed on to the adherend. Atthistime, air between the adherend and the pressure-sensitive adhesive surface 1B of the pressure-sensitive adhesive layer 12 escapes from the through-holes 2 formed in the pressure-sensitive adhesive sheet 1 to the outside of the pressure-sensitive adhesive sheet front surface 1A, and hence air tends not to be caught up between the adherend and the pressure-sensitive adhesive surface 1B, i.e. air entrapment is prevented from occurring. Even if air is caught up so that air entrapment occurs,byre-pressing the air-entrappedportion or an air-entrapped portion surrounding portion including the air-entrapped portion, the air can be made to escape from the through-holes 2 to the outside of the pressure-sensitive adhesive sheet front surface 1A, thus eliminating the air entrapment. Such elimination of air entrapment is possible even after a long time has elapsed after the sticking on of the pressure-sensitive adhesive sheet 1.

[Example 4]

[0070] A pressure-sensitive adhesive sheet was produced as in Example 1, except that a UV-YAG laser was used in the laser processing, and the through-holes were made to have a diameter at the substrate surface of approximately 30 μm, and a diameter at the pressure-sensitive adhesive surface of approximately 50 μm. Melted portions (maximum height: 4 μm) on the substrate surface of the pressure-sensitive adhesive sheet had an outside diameter of approximately 35 μm, and there were no thermally deformed portions.

[Example 5]

[0071] A pressure-sensitive adhesive sheet was produced as in Example 1, except that an excimer laser was used in the laser processing, and the through-holes were made to have a diameter at the substrate surface of approximately 0.1 to 10 μm, and a diameter at the pressure-sensitive adhesive surface of approximately 25 μm. There were nomelted portions or thermally deformed portions on the substrate surface of the pressure-sensitive adhesive sheet.

[Example 6]

[0072] A pressure-sensitive adhesive sheet was produced as in Example 5, except that the through-holes were made to have a diameter at the substrate surface of approximately 40 μm, and a diameter at the pressure-sensitive adhesive surface of approximately 65 μm. There were nomelted portions or thermally deformed portions on the substrate surface of the pressure-sensitive adhesive sheet.

[Example 7]

[0073] A pressure-sensitive adhesive sheet was produced as in Example 2, except that a black opaque substrate (thickness: 100 μm) made of a polyvinyl chloride resin having a surface roughness (Ra) of 0.507 μm, a chroma (C*) in the L*a*b* color system of 0.34 and a lightness (L*) of 26.58, and a contrast ratio of 98.4% was used as the substrate. Melted portions (maximum height: 3 μm) on the substrate surface of the pressure-sensitive adhesive sheet had an outside diameter of approximately 45 μm, and there were no thermally deformed portions.

[Example 8]

[0074] A pressure-sensitive adhesive sheet was produced as in Example 1, except that a black opaque substrate (thickness: 100 μm) made of a polyvinyl chloride resin having a surface roughness (Ra) of 0.220 μm, a chroma (C*) in the L*a*b* color system of 0.49 and a lightness (L*) of 25.81, and a contrast ratio of 99.9% was used as the substrate, and the through-holes were made to have a diameter at the substrate surface of approximately 35 μm. Melted portions (maximum height: 4 μm) on the substrate surface of the pressure-sensitive adhesive sheet had an outside diameter of approximately 40μm, and there were no thermally deformed portions.

[Example 9]

[0075] A pressure-sensitive adhesive sheet was produced as in Example 8, except that an excimer laser was used in the laser processing, and the through-holes were made to have a diameter at the substrate surface of approximately 40 μm, and a diameter at the pressure-sensitive adhesive surface of approximately 65 μm. There were no melted portions or thermally deformed portions on the substrate surface of the pressure-sensitive adhesive sheet.

[Example 10]

[0076] Using as a casting sheet a polyethylene terephthalate film (made by TEIJIN DUPONT FILMS JAPAN LIMITED, U4Z-50, thickness: 50 μm) one surface of which had been subjected to release treatment, a black opaque substrate (thickness: 55 μm) made of a polyvinyl chloride resin having a surface roughness (Ra) of 0.218 μm, a chroma (C*) in the L*a*b* color system of 0.78 and a lightness (L*) of 27.33, and a contrast ratio of 97.0% was formed using a casting method.

[0077] On the other hand, a pressure-sensitive adhesive layer was formed on a release liner as in Example 1, and then this pressure-sensitive adhesive layer and the above substrate with casting sheet were superposed together such that the pressure-sensitive adhesive layer and the opposite surface of the above substrate were attached firmly, whereby a laminate having a four-layer structure was obtained.

[0078] The release liner was peeled off from the laminate obtained, and the laminate was irradiated with a CO_2 laser

[Example 16]

[0089] A pressure-sensitive adhesive layer was formed on a release liner as in Example 1, a black opaque substrate (thickness: 100 μm) made of a polyolefin type thermoplastic elastomer having a colorless transparent acrylic coating (thickness: 5 μm) on a surface thereof and having a surface roughness (Ra) of 0.373 μm, a chroma (C*) in the L*a*b* color system of 0.34 and a lightness (L*) of 27.39, and a contrast ratio of 99.3% was pressed onto the pressure-sensitive adhesive layer, and then a polyethylene film with removable pressure-sensitive adhesive layer (made by SUMIRON CO., LTD., E-212, thickness: 60 μm) was further stuck as a protective sheet onto the surface of the substrate, whereby a laminate having a four-layer structure was obtained.

[0090] The release liner was peeled off from the laminate, and the laminate was irradiated with a CO_2 laser from the pressure-sensitive adhesive layer side, thus forming at a hole density of 2500 per 100 cm^2 through-holes having a diameter at the substrate surface of approximately 20 μm and a diameter at the pressure-sensitive adhesive surface of approximately 120 μm (the diameter being a maximum at the pressure-sensitive adhesive surface). The release liner was then superposed again onto the pressure-sensitive adhesive layer, whereby a pressure-sensitive adhesive sheet was obtained. Thermally deformed portions (concave, maximum depth: 5μm) on the substrate surface of the pressure-sensitive adhesive sheet had an outside diameter of approximately 150 μm, and there were no melted portions.

[Example 17]

[0091] A pressure-sensitive adhesive layer was formed as in Example 1 on the release treated surface of a release liner (made by TOYOBO CO., LTD., Crisper G-7223, thickness: 125 μm) obtained by subjecting one surface of a polyethylene terephthalate film to release treatment with a silicone type release agent, and a black opaque substrate (made by TEIJIN CHEMICALS LTD., Ecocaru α series black film, thickness: 45 μm) comprising a polyester type thermoplastic elastomer layer (thickness: 40 μm) with an anchor coat layer (thickness: 1 μm), a black colored layer (thickness: 2 μm) and a colorless transparent acrylic coating (thickness: 2 μm) laminated thereon in this order, and having a surface roughness (Ra) of 0.040 μm, a chroma (C*) in the L*a*b* color system of 1.77 and a lightness (L*) of 26.67, and a contrast ratio of 99.9% was superposed onto the pressure-sensitive adhesive layer. A polyethylene film with removable pressure-sensitive adhesive layer (made by SUMIRON CO., LTD., E-2035, thickness: 60 μm) was then further stuck as a protective sheet onto the surface of the substrate, whereby a laminate having a four-layer structure was obtained.

[0092] The modulus of elasticity in tension of the substrate was measured in accordance with JIS K7161 and JIS K7127 under the following conditions, and was 526 MPa.

- Measurement apparatus: TENSILON RTA-100 made by Orientec
  Width of test piece (type 2): 15 mm
  Initial inter-chuck distance: 100 mm
- Test speed: 200 mm/min

[0093] The release liner was peeled off from the laminate, and the laminate was irradiated with a CO_2 laser from the pressure-sensitive adhesive layer side, thus forming at a hole density of 2500 per 100 cm^2 through-holes having a diameter at the substrate surface of approximately 20 μm and a diameter at the pressure-sensitive adhesive surface of approximately 60 μm (the diameter being a maximum at the pressure-sensitive adhesive surface). The release liner was then superposed again onto the pressure-sensitive adhesive layer, whereby a pressure-sensitive adhesive sheet was obtained. Thermally deformed portions (concave, maximumdepth: 5μm) on the substrate surface of the pressure-sensitive adhesive sheet had an outside diameter of approximately 50μm, and there were no melted portions.

[Comparative Example 1]

[0094] A pressure-sensitive adhesive sheet was produced as in Example 1, except that the through-holes were made to have a diameter at the substrate surface of approximately 60 μm, and a diameter at the pressure-sensitive adhesive surface of approximately 100 μm. There were no melted portions or thermally deformed portions on the substrate surface of the pressure-sensitive adhesive sheet.

[Comparative Example 2]

[0095] A pressure-sensitive adhesive sheet was produced as in Example 1, except that the through-holes were made to have a diameter at the substrate surface of approximately 40 μm, and a diameter at the pressure-sensitive adhesive surface of approximately 85 μm. Melted portions (maximum height: 5 μm) on the substrate surface of the pressure-sensitive adhesive sheet had an outside diameter of approximately 70 μm, and there were no thermally deformed portions.

(continued)

	Air entrapment removability test	Hole visibility inspection (not stretched)	Hole visibility inspection (Stretched by 3%)	Air permeability resistance (sec)
Example 8	O	O	O	48
Example 9	O	O	O	35
Example 10	O	O	O	91
Example 11	O	O	O	93
Example 12	O	O	O	88
Example 13	O	O	O	203
Example 14	O	O	O	201
Example 15	O	O	O	197
Example 16	O	O	×	245
Example 17	O	O	×	205
Comparative Example 1	O	×	×	12
Comparative Example 2	O	×	×	32
Comparative Example 3	O	×	×	95

[0101] As can be seen from Table 1, for the pressure-sensitive adhesive sheets satisfying the conditions of the present invention (Examples 1 to 17), none of the through-holes, melted portions or thermally deformed portions could be seen with the naked eye, and hence the appearance was very good. Moreover, for the pressure-sensitive adhesive sheets in which the through-holes had a diameter in the substrate and the pressure-sensitive adhesive layer of not more than 85 μm (Examples 1, 2, and 4 to 15), even when stuck on stretched by a elongation of 3%, none of the through-holes, melted portions or thermally deformed portions could be seen with the naked eye, and hence the appearance was very good.

INDUSTRIAL APPLICABILITY

[0102] The pressure-sensitive adhesive sheet of the present invention can be favorably used in the case that air entrapment or blistering would be prone to occur with a general pressure-sensitive adhesive sheet, for example in the case that the pressure-sensitive adhesive sheet has a large area; or the case that gas is emitted from the adherend, and moreover it is required that through-holes, melted portions and thermally deformed portions cannot be seen.

Claims

1. A pressure-sensitive adhesive sheet comprising a substrate having a surface roughness (Ra) of not less than 0.03 μm, a lightness (L*) in the L*a*b* color system of not more than 60 in the case of having a chroma (C*) of not more than 60 and a lightness (L*) of not more than 85 in the case of having a chroma (C*) greater than 60, and a contrast ratio of not less than 90%, and a pressure-sensitive adhesive layer, the pressure-sensitive adhesive sheet wherein:

   the pressure-sensitive adhesive sheet is formed with a plurality of through-holes passing through from one surface to the other surface thereof at a hole density of from 30 to 50,000 per 100 cm^2 through laser processing;
   said through-holes have a diameter in said substrate and said pressure-sensitive adhesive layer of from 0.1 to 200 μm;
   said through-holes have a diameter at a surface of said substrate of from 0.1 to 42 μm;
   melted portions formed by the laser around said through-holes at the surface of said substrate have an outside diameter of not more than 50 μm; and

Fig.1

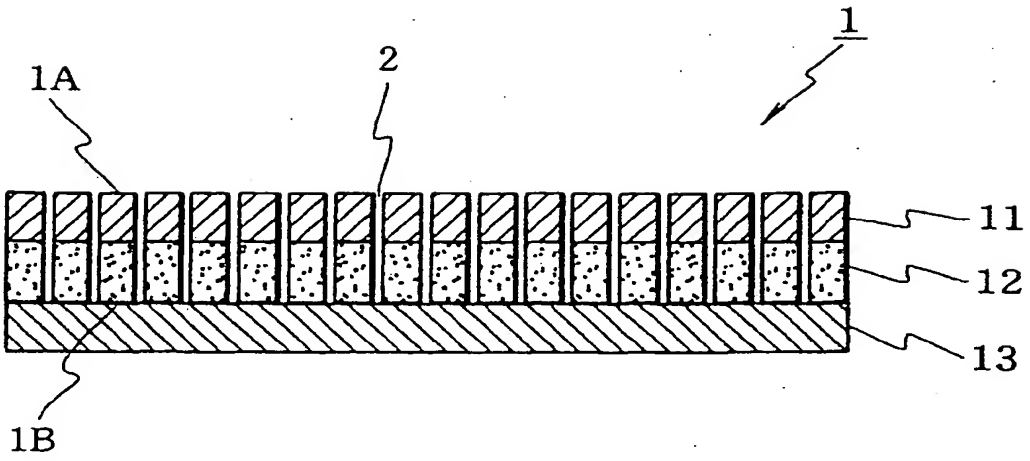


Fig.2

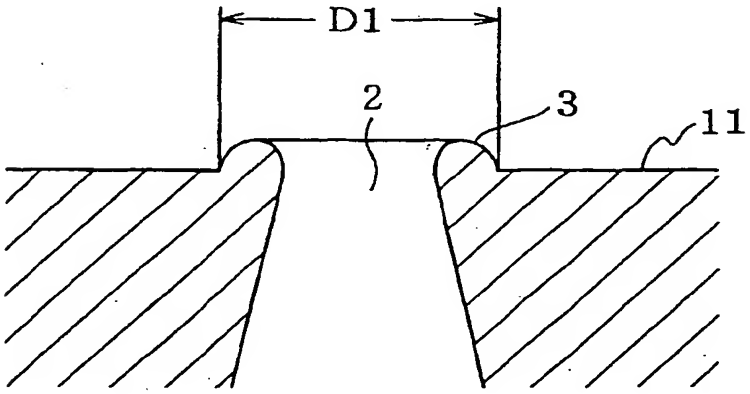
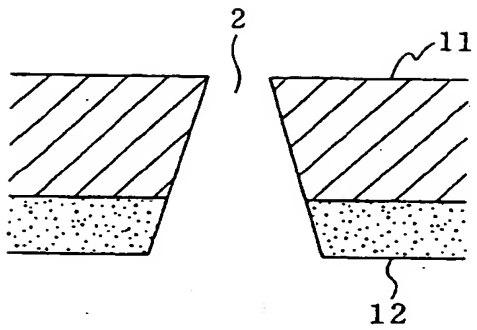


Fig.4

(a)



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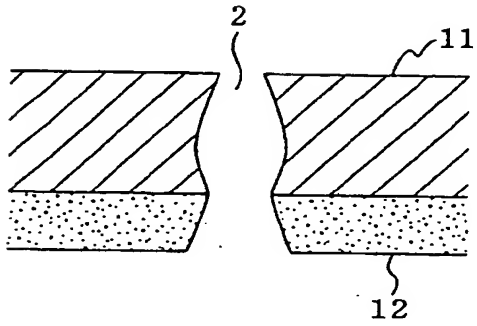

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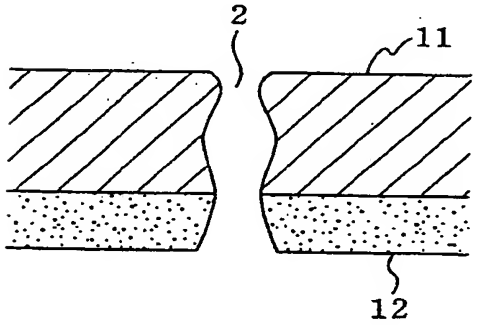
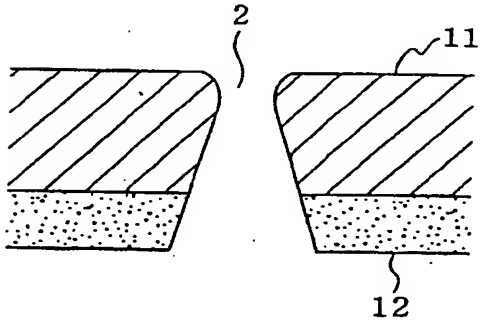


(d)



INTERNATIONAL SEARCH REPORT

International application No.
PCT/JP2005/010510

A. CLASSIFICATION OF SUBJECT MATTER
Int.Cl[7] C09J7/02

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
Int.Cl[7] C09J7/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2005
Kokai Jitsuyo Shinan Koho 1971-2005 Toroku Jitsuyo Shinan Koho 1994-2005

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 01/51580 A1 (Nitto Denko Corp.), 19 July, 2001 (19.07.01), Page 3, lines 8 to 19 & US 2005-74578 A1 & US 6890617 B1 & EP 1270694 A1	1-3
A	JP 2003-183602 A (Sekisui Chemical Co., Ltd.), 03 July, 2003 (03.07.03), Par. Nos. [0023] to [0024] (Family: none)	1-3
A	JP 4-55489 A (Sekisui Chemical Co., Ltd.), 24 February, 1992 (24.02.92), Claims (Family: none)	1-3

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
16 September, 2005 (16.09.05)	04 October, 2005 (04.10.05)
Name and mailing address of the ISA/ Japanese Patent Office Facsimile No.	Authorized officer Telephone No.

Form PCT/ISA/210 (second sheet) (January 2004)